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MANUAL OF PATENT EXAMINING PROCEDURE
CHAPTER 2100 PATENTABILITY

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2181 Identifying a 35 U.S.C. 112, Sixth Paragraph Limitation [R-3]

This section sets forth guidelines for the examination of 35 U.S.C. 112, sixth paragraph, "means or step plus function" limitations in a claim. These guidelines are based on the Office's current understanding of the law and are believed to be fully consistent with binding precedent of the Supreme Court, the Federal Circuit and the Federal Circuit's predecessor courts. These guidelines do not constitute substantive rulemaking and hence do not have the force and effect of law.

The Court of Appeals for the Federal Circuit, in its en banc decision *In re Donaldson Co.*, 16 F.3d 1189, 29 USPQ2d 1845 (Fed. Cir. 1994), decided that a "means-or-step-plus-function" limitation should be interpreted in a manner different than patent examining practice had previously dictated. The *Donaldson* decision affects only the manner in which the scope of a "means or step plus function" limitation in accordance with 35 U.S.C. 112, sixth paragraph, is interpreted during examination. *Donaldson* does not directly affect the manner in which any other section of the patent statutes is interpreted or applied.

When making a determination of patentability under 35 U.S.C. 102 or 103, past practice was to interpret a "means or step plus function" limitation by giving it the "broadest reasonable interpretation." Under the PTO's long-standing practice this meant interpreting such a limitation as reading on any prior art means or step which performed the function specified in the claim without regard for whether the prior art means or step was equivalent to the corresponding structure, material or acts described in the specification. However, in *Donaldson*, the Federal Circuit stated:

Per our holding, the "broadest reasonable interpretation" that an examiner may give means-plus-function language is that statutorily mandated in paragraph six. Accordingly, the PTO may not disregard the structure disclosed in the specification corresponding to such language when rendering a patentability determination.

I. LANGUAGE FALLING WITHIN 35 U.S.C. 112, SIXTH PARAGRAPH

The USPTO must apply 35 U.S.C. 112, sixth paragraph in appropriate cases, and give claims their broadest reasonable interpretation, in light of and consistent with the written description of the invention in the application. See *Donaldson*, 16 F.3d at 1194, 29 USPQ2d at 1850 (stating that 35 U.S.C. 112, sixth paragraph "merely sets a limit on how broadly the PTO may construe means-plus-function language under the rubric of reasonable interpretation.'). The Federal Circuit has held that applicants (and reexamination patentees) before the USPTO have the opportunity and the obligation to define their inventions precisely during proceedings before the PTO. See *In re Morris*, 127 F.3d 1048, 1056-57, 44 USPQ2d 1023, 1029-30 (Fed. Cir. 1997) (35 U.S.C. 112, second paragraph places the burden of precise claim drafting on the applicant); *In re Zletz*, 893 F.2d 319, 322, 13 USPQ2d 1320, 1322 (Fed. Cir. 1989) (manner of claim interpretation that is used

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by courts in litigation is not the manner of claim interpretation that is applicable during prosecution of a pending application before the PTO); *Sage Prods., Inc. v. Devon Indus., Inc.*, 126 F.3d 1420, 1425, 44 USPQ2d 1103, 1107 (Fed. Cir. 1997) (patentee who had a clear opportunity to negotiate broader claims during prosecution but did not do so, may not seek to expand the claims through the doctrine of equivalents, for it is the patentee, not the public, who must bear the cost of failure to seek protection for this foreseeable alteration of its claimed structure). Applicants and reexamination patentees before the USPTO have an opportunity and obligation to specify, consistent with these guidelines, when a claim limitation invokes 35 U.S.C. 112, sixth paragraph.

A claim limitation will be interpreted to invoke 35 U.S.C. 112, sixth paragraph, if it meets the following 3-prong analysis:

- (A) the claim limitations must use the phrase "means for" or "step for;"
- (B) the "means for" or "step for" must be modified by functional language; and
- (C) the phrase "means for" or "step for" must not be modified by sufficient structure, material or acts for achieving the specified function.

With respect to the first prong of this analysis, a claim element that does not include the phrase "means for" or "step for" will not be considered to invoke 35 U.S.C. 112, sixth paragraph. If an applicant wishes to have the claim limitation treated under 35 U.S.C. 112, sixth paragraph, applicant must either: (A) amend the claim to include the phrase "means for" or "step for" in accordance with these guidelines; or (B) show that even though the phrase "means for" or "step for" is not used, the claim limitation is written as a function to be performed and does not recite sufficient structure, material, or acts which would preclude application of 35 U.S.C. 112, sixth paragraph. See *Watts v. XL Systems, Inc.*, 232 F.3d 877, 56 USPQ2d 1836 (Fed. Cir. 2000) (Claim limitations were held not to invoke 35 U.S.C. 112, sixth paragraph, because the absence of the term "means" raised the presumption that the limitations were not in means-plus-function form, nor was the presumption rebutted.); see also *Masco Corp. v. United States*, 303 F.3d 1316, 1327, 64 USPQ2d 1182, 1189 (Fed. Cir. 2002) ("[W]here a method claim does not contain the term 'step[s] for,' a limitation of that claim cannot be construed as a step-plus-function limitation without a showing that the limitation contains no act.").

While traditional "means for" or "step for" language does not automatically make an element a means-(or step-) plus-function element, conversely, lack of such language does not prevent a limitation from being construed as a means-(or step-) plus-function limitation. See *Signtech USA, Ltd. v. Vutek, Inc.*, 174 F.3d 1352, 1356, 50 USPQ2d 1372, 1374- 75 (Fed. Cir.1999) ("ink delivery means positioned on..." invokes 35 U.S.C. 112, sixth paragraph since the phrase "ink delivery means" is equivalent to "means for ink delivery"); *Al-Site Corp. v. VSI Int'l, Inc.*, 174 F.3d 1308, 1317- 19, 50 USPQ2d 1161, 1166-67 (Fed. Cir. 1999) (although the claim elements "eyeglass hanger member" and "eyeglass contacting member" include a function, these claim elements do not invoke 35 U.S.C. 112, sixth paragraph because the claims themselves contain sufficient structural limitations for performing these functions); *Seal-Flex, Inc. v. Athletic Track and Court Construction*, 172 F.3d 836, 850, 50 USPQ2d 1225, 1234 (Fed. Cir. 1999) (Radar, J., concurring) ("claim elements without express step-plus-function language may nevertheless fall within 112 6 if they merely claim the underlying function

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without recitation of acts for performing that function...In general terms, the underlying function' of a method claim element corresponds to what that element ultimately accomplishes in relationship to what the other elements of the claim and the claim as a whole accomplish. Acts,' on the other hand, correspond to how the function is accomplished...If the claim element uses the phrase step for,' then § 112, 6 is presumed to apply...On the other hand, the term step' alone and the phrase steps of' tend to show that § 112, 6 does not govern that limitation."); *Personalized Media Communications LLC v. ITC*, 161 F.3d 696, 703-04, 48 USPQ2d 1880, 1886-87 (Fed. Cir. 1998); *Mas-Hamilton Group v. LaGard Inc.*, 156 F.3d 1206, 1213, 48 USPQ2d 1010, 1016 (Fed. Cir. 1998) ("lever moving element for moving the lever" and "movable link member for holding the lever...and for releasing the lever" were construed as means-plus-function limitations invoking 35 U.S.C. 112, sixth paragraph since the claimed limitations were described in terms of their function not their mechanical structure); *Ethicon, Inc. v. United States Surgical Corp.*, 135 F.3d 1456, 1463, 45 USPQ2d 1545, 1550 (Fed. Cir. 1998) ("use of the word means 'gives rise to a presumption that the inventor used the term advisedly to invoke the statutory mandates for means-plus-function clauses'"); *O.I. Corp. v. Tekmar*, 115 F.3d 1576, 1583, 42 USPQ2d 1777, 1782 (Fed. Cir. 1997) (method claim that paralleled means-plus-function apparatus claim but lacked "step for" language did not invoke 35 U.S.C. 112, sixth paragraph). Thus, absent an express recitation of "means for" or "step for" in the limitation, the broadest reasonable interpretation will not be limited to "corresponding structure...and equivalents thereof." *Morris*, 127 F.3d at 1055, 44 USPQ2d at 1028 ("no comparable mandate in the patent statute that relates the claim scope of non-§ 112 paragraph 6 claims to particular matter found in the specification").

With respect to the second prong of this analysis, see *York Prod., Inc. v. Central Tractor Farm & Family Center*, 99 F.3d 1568, 1574, 40 USPQ2d 1619, 1624 (Fed. Cir. 1996) (holding that a claim limitation containing the term "means" does not invoke 35 U.S.C. 112, sixth paragraph, if the claim limitation does not link the term "means" to a specific function). It must be clear that the element in the claims is set forth, at least in part, by the function it performs as opposed to the specific structure, material, or acts that perform the function. See also *Caterpillar Inc. v. Detroit Diesel Corp.*, 41 USPQ2d 1876, 1882 (N.D. Ind. 1996) (35 U.S.C. 112, sixth paragraph, "applies to functional method claims where the element at issue sets forth a step for reaching a particular result, but not the specific technique or procedure used to achieve the result."); *O.I. Corp.*, 115 F.3d at 1582-83, 42 USPQ2d at 1782 (With respect to process claims, "[35 U.S.C. 112, sixth paragraph] is implicated only when steps plus function without acts are present...If we were to construe every process claim containing steps described by an 'ing' verb, such as passing, heating, reacting, transferring, etc., into a step-plus-function, we would be limiting process claims in a manner never intended by Congress." (Emphasis in original).). However, "the fact that a particular mechanism...is defined in functional terms is not sufficient to convert a claim element containing that term into a 'means for performing a specified function' within the meaning of section 112(6)."

Greenberg v. Ethicon Endo-Surgery, Inc., 91 F.3d 1580, 1583, 39 USPQ2d 1783, 1786 (Fed. Cir. 1996) ("detent mechanism" defined in functional terms was not intended to invoke 35 U.S.C. 112, sixth paragraph). See also *Al-Site Corp. v. VSI*

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International Inc., 174 F.3d 1308, 1318, 50 USPQ2d 1161, 1166-67 (Fed. Cir. 1999) (although the claim elements "eyeglass hanger member" and "eyeglass contacting member" include a function, these claim elements do not invoke 35 U.S.C. 112, sixth paragraph, because the claims themselves contain sufficient structural limitations for performing those functions). Also, a statement of function appearing only in the claim preamble is generally insufficient to invoke 35 U.S.C. 112, sixth paragraph. O.I. Corp., 115 F.3d at 1583, 42 USPQ2d at 1782 ("[A] statement in a preamble of a result that necessarily follows from performing a series of steps does not convert each of those steps into step-plus-function clauses. The steps of 'passing' are not individually associated in the claims with functions performed by the steps of passing.").

With respect to the third prong of this analysis, see Seal-Flex, 172 F.3d at 849, 50 USPQ2d at 1234 (Radar, J., concurring) ("Even when a claim element uses language that generally falls under the step-plus-function format, however, 112 ¶ 6 still does not apply when the claim limitation itself recites sufficient acts for performing the specified function."); Enviroco Corp. v. Clestra Cleanroom, Inc., 209 F.3d 1360, 54 USPQ2d 1449 (Fed. Cir. 2000) (holding "second baffle means" does not invoke 35 U.S.C. 112, sixth paragraph, because the word "baffle" itself imparts structure and the claim further recites the structure of the baffle); Rodime PLC v. Seagate Technology, Inc., 174 F.3d 1294, 1303-04, 50 USPQ2d 1429, 1435-36 (Fed. Cir. 1999) (holding "positioning means for moving" does not invoke 35 U.S.C. 112, sixth paragraph, because the claim further provides a list of the structure underlying the means and the detailed recitation of the structure for performing the moving function removes this element from the purview of 35 U.S.C. 112, sixth paragraph); Cole v. Kimberly-Clark Corp., 102 F.3d 524, 531, 41 USPQ2d 1001, 1006 (Fed. Cir. 1996) (holding "perforation means...for tearing" does not invoke 35 U.S.C. 112, sixth paragraph, because the claim describes the structure supporting the tearing function (i.e., perforation)). In other cases, the Federal Circuit has held otherwise. See Unidynamics Corp. v. Automatic Prod. Int'l, 157 F.3d 1311, 1319, 48 USPQ2d 1099, 1104 (Fed. Cir. 1998) (holding "spring means" does invoke 35 U.S.C. 112, sixth paragraph). During examination, however, applicants have the opportunity and the obligation to define their inventions precisely, including whether a claim limitation invokes 35 U.S.C. 112, sixth paragraph. Thus, if the phrase "means for" or "step for" is modified by sufficient structure, material or acts for achieving the specified function, the USPTO will not apply 35 U.S.C. 112, sixth paragraph, until such modifying language is deleted from the claim limitation.

It is necessary to decide on an element by element basis whether 35 U.S.C. 112, sixth paragraph, applies. Not all terms in a means-plus-function or step-plus-function clause are limited to what is disclosed in the written description and equivalents thereof, since 35 U.S.C. 112, sixth paragraph, applies only to the interpretation of the means or step that performs the recited function. See, e.g., IMS Technology Inc. v. Haas Automation Inc., 206 F.3d 1422, 54 USPQ2d 1129 (Fed. Cir. 2000) (the term "data block" in the phrase "means to sequentially display data block inquiries" was not the means that caused the sequential display, and its meaning was not limited to the disclosed embodiment and equivalents thereof). Each claim must be independently reviewed to determine the applicability of 35 U.S.C. 112, sixth paragraph, even where the application

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contains substantially similar process and apparatus claims. O.I. Corp., 115 F.3d at 1583-1584, 42 USPQ2d at 1782 ("We understand that the steps in the method claims are essentially in the same language as the limitations in the apparatus claim, albeit without the 'means for' qualification...Each claim must be independently reviewed in order to determine if it is subject to the requirements of section 112, ¶ 6. Interpretation of claims would be confusing indeed if claims that are not means- or step-plus function were to be interpreted as if they were, only because they use language similar to that used in other claims that are subject to this provision.").

>Where a claim limitation meets the 3-prong analysis and is being treated under 35 U.S.C. 112, sixth paragraph, the examiner will include a statement in the Office action that the claim limitation is being treated under 35 U.S.C. 112, sixth paragraph. However, if a claim limitation does not use the phrase "means for" or "step for," that is, the first prong of the 3-prong analysis is not met, the examiner will not treat such a claim limitation under 35 U.S.C. 112, sixth paragraph. It will not be necessary to state in the Office action that 35 U.S.C. 112, sixth paragraph, has not been invoked, since the presumption is that applicant did not intend to invoke the provisions of 35 U.S.C. 112, sixth paragraph, because applicant did not use the specific phrase "means for" or "step for." If a claim limitation does include the phrase "means for" or "step for," that is, the first prong of the 3-prong analysis is met, but the examiner determines that either the second prong or the third prong of the 3-prong analysis is not met, then in these situations, the examiner must include a statement in the Office action explaining the reasons why a claim limitation which uses the phrase "means for" or "step for" is not being treated under 35 U.S.C. 112, sixth paragraph.<

Accordingly, these guidelines provide applicants with the opportunity to either invoke or not invoke 35 U.S.C. 112, sixth paragraph, based upon a clear and simple set of criteria.

**>The following examples illustrate situations where the phrase "means for" or "step for" was not used but the Board or the courts determined that the claim limitation falls within the scope of 35 U.S.C. 112, sixth paragraph. Note that the examples are fact specific and should not be applied as per se rules. As noted above, examiners should apply the 3-prong analysis to determine whether the claim limitation will be interpreted to invoke 35 U.S.C. 112, sixth paragraph. A claim element that does not include the phrase "means for" or "step for" will not be considered to invoke 35 U.S.C. 112, sixth paragraph. If an applicant wishes to have the claim limitation treated under 35 U.S.C. 112, sixth paragraph, applicant must either amend the claim to include the phrase "means for" or "step for," or show that even though the phrase "means for" or "step for" is not used, the claim limitation is written as a function to be performed and does not recite sufficient structure, material, or acts which would preclude application of 35 U.S.C. 112, sixth paragraph.<

(A) a jet driving device so constructed and located on the rotor as to drive the rotor . . . ["means" unnecessary]. The term "device" coupled with a function is a proper definition of structure in accordance with the last paragraph of 35 U.S.C. 112. The addition of the words "jet driving" to the term "device" merely renders the latter more definite and specific. Ex parte Stanley, 121 USPQ 621

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(Bd. App. 1958);

(B) "printing means" and "means for printing" which would have the same connotations. Ex parte Klumb, 159 USPQ 694 (Bd. App. 1967). However, the terms "plate" and "wing," as modifiers for the structureless term "means," specify no function to be performed, and do not fall under the last paragraph of 35 U.S.C. 112;

(C) force generating means adapted to provide De Graffenreid v. United States, 20 Ct. Cl. 458, 16 USPQ2d 1321 (Ct. Cl. 1990);

(D) call cost register means, including a digital display for providing a substantially instantaneous display for Intellicall Inc. v. Phonometrics, Inc., 952 F.2d 1384, 21 USPQ2d 1383 (Fed. Cir. 1992);

(E) reducing the coefficient of friction of the resulting film [step plus function; "step" unnecessary], In re Roberts, 470 F.2d 1399, 176 USPQ 313 (CCPA 1973); and

(F) raising the pH of the resultant pulp to about 5.0 to precipitate Ex parte Zimmerley, 153 USPQ 367 (Bd. App. 1966).

In the event that it is unclear whether the claim limitation falls within the scope of 35 U.S.C. 112, sixth paragraph, a rejection under 35 U.S.C. 112, second paragraph may be appropriate.

II. WRITTEN DESCRIPTION NECESSARY TO SUPPORT A CLAIM LIMITATION WHICH INVOKES 35 U.S.C. 112, SIXTH PARAGRAPH

35 U.S.C. 112, sixth paragraph states that a claim limitation expressed in means-plus-function language "shall be construed to cover the corresponding structure...described in the specification and equivalents thereof." "If one employs means plus function language in a claim, one must set forth in the specification an adequate disclosure showing what is meant by that language. If an applicant fails to set forth an adequate disclosure, the applicant has in effect failed to particularly point out and distinctly claim the invention as required by the second paragraph of section 112." In re Donaldson Co., 16 F.3d 1189, 1195, 29 USPQ2d 1845, 1850 (Fed. Cir. 1994) (in banc).

The proper test for meeting the definiteness requirement is that the corresponding structure (or material or acts) of a means (or step)-plus-function limitation must be disclosed in the specification itself in a way that one skilled in the art will understand what structure (or material or acts) will perform the recited function. See Atmel Corp. v. Information Storage Devices, Inc., 198 F.3d 1374, 1381, 53 USPQ2d 1225, 1230 (Fed. Cir. 1999). In Atmel, the patentee claimed an apparatus that included a "high voltage generating means" limitation, thereby invoking 35 U.S.C. 112, sixth paragraph. The specification incorporated by reference a non-patent document from a technical journal, which described a particular high voltage generating circuit. The Federal Circuit concluded that the title of the article in the specification may, by itself, be sufficient to indicate to one skilled in the art the precise structure of the means for performing the recited function, and it remanded the case to the district court "to consider the knowledge of one skilled in the art that indicated, based on unrefuted testimony, that the specification disclosed sufficient structure corresponding to the high-voltage means limitation." Id. at 1382, 53 USPQ2d at 1231.

The disclosure of the structure (or material or acts) may be implicit or

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inherent in the specification if it would have been clear to those skilled in the art what structure (or material or acts) corresponds to the means (or step)-plus-function claim limitation. See *Id.* at 1380, 53 USPQ2d at 1229; *In re Dossel*, 115 F.3d 942, 946-47, 42 USPQ2d 1881, 1885 (Fed. Cir. 1997). If there is no disclosure of structure, material or acts for performing the recited function, the claim fails to satisfy the requirements of 35 U.S.C. 112, second paragraph. *Budde v. Harley-Davidson, Inc.*, 250 F.3d 1369, 1376, 58 USPQ2d 1801, 1806 (Fed. Cir. 2001); *Cardiac Pacemakers, Inc. v. St. Jude Med., Inc.*, 296 F.3d 1106, 1115-18, 63 USPQ2d 1725, 1731-34 (Fed. Cir. 2002) (Court interpreted the language of the "third monitoring means for monitoring the ECG signal...for activating..." to require the same means to perform both functions and the only entity referenced in the specification that could possibly perform both functions is the physician. The court held that excluding the physician, no structure accomplishes the claimed dual functions. Because no structure disclosed in the embodiments of the invention actually performs the claimed dual functions, the specification lacks corresponding structure as required by 35 U.S.C. 112, sixth paragraph, and fails to comply with 35 U.S.C. 112, second paragraph.).

Whether a claim reciting an element in means- (or step-) plus-function language fails to comply with 35 U.S.C. 112, second paragraph, because the specification does not disclose adequate structure (or material or acts) for performing the recited function is closely related to the question of whether the specification meets the description requirement in 35 U.S.C. 112, first paragraph. See *In re Noll*, 545 F.2d 141, 149, 191 USPQ 721, 727 (CCPA 1976) (unless the means-plus-function language is itself unclear, a claim limitation written in means-plus-function language meets the definiteness requirement in 35 U.S.C. 112, second paragraph, so long as the specification meets the written description requirement in 35 U.S.C. 112, first paragraph). However, 35 U.S.C. 112, sixth paragraph, does not impose any requirements in addition to those imposed by 35 U.S.C. 112, first paragraph. See *In re Knowlton*, 481 F.2d 1357, 1366, 178 USPQ 486, 492-93 (CCPA 1973). Conversely, the invocation of 35 U.S.C. 112, sixth paragraph, does not exempt an applicant from compliance with 35 U.S.C. 112, first and second paragraphs. See *Donaldson*, 16 F.3d at 1195, 29 USPQ2d at 1850; *Knowlton*, 481 F.2d at 1366, 178 USPQ at 493.

Under certain limited circumstances, the written description does not have to explicitly describe the structure (or material or acts) corresponding to a means- (or step-) plus-function limitation to particularly point out and distinctly claim the invention as required by 35 U.S.C. 112, second paragraph. See *Dossel*, 115 F.3d at 946, 42 USPQ2d at 1885. Under proper circumstances, drawings may provide a written description of an invention as required by 35 U.S.C. 112. *Vas-Cath, Inc. v. Mahurkar*, 935 F.2d 1555, 1565, 19 USPQ2d 1111, 1118 (Fed. Cir. 1991). Rather, disclosure of structure corresponding to a means-plus-function limitation may be implicit in the written description if it would have been clear to those skilled in the art what structure must perform the function recited in the means-plus-function limitation. See *Atmel Corp. v. Information Storage Devices Inc.*, 198 F.3d 1374, 1379, 53 USPQ2d 1225, 1228 (Fed. Cir. 1999) (stating that the "one skilled in the art" analysis should apply in determining whether sufficient structure has been disclosed to support a means-plus-function limitation and that the USPTO's recently issued proposed Supplemental Guidelines

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are consistent with the court's holding on this point); Dossel, 115 F.3d at 946-47, 42 USPQ2d at 1885 ("Clearly, a unit which receives digital data, performs complex mathematical computations and outputs the results to a display must be implemented by or on a general or special purpose computer (although it is not clear why the written description does not simply state 'computer' or some equivalent phrase.)").

III. DETERMINING 35 U.S.C. 112 SECOND PARAGRAPH COMPLIANCE WHEN 35 U.S.C. 112 SIXTH PARAGRAPH IS INVOKED

The following guidance is provided to determine whether applicant has complied with the requirements of 35 U.S.C. 112, second paragraph, when 35 U.S.C. 112, sixth paragraph, is invoked:

(A) If the corresponding structure, material or acts are described in the specification in specific terms (e.g., an emitter-coupled voltage comparator) and one skilled in the art could identify the structure, material or acts from that description, then the requirements of 35 U.S.C. 112, second and sixth paragraphs and are satisfied. See *Atmel*, 198 F.3d at 1382, 53 USPQ2d 1231.

(B) If the corresponding structure, material or acts are described in the specification in broad generic terms and the specific details of which are incorporated by reference to another document (e.g., attachment means disclosed in U.S. Patent No. X, which is hereby incorporated by reference, or a comparator as disclosed in the IBM article, which is hereby incorporated by reference), Office personnel must review the description in the specification, without relying on any material from the incorporated document, and apply the "one skilled in the art" analysis to determine whether one skilled in the art could identify the corresponding structure (or material or acts) for performing the recited function to satisfy the definiteness requirement of 35 U.S.C. 112, second paragraph. >See *Default Proof Credit Card System, Inc. v. Home Depot U.S.A., Inc.*, 412 F.3d 1291, 75 USPQ2d 1116 (Fed. Cir. 2005) ("The inquiry under [35 U.S.C.] § 112, ¶ 2, does not turn on whether a patentee has 'incorporated by reference' material into the specification relating to structure, but instead asks first 'whether structure is described in the specification, and, if so, whether one skilled in the art would identify the structure from that description'").<

(1) If one skilled in the art would be able to identify the structure, material or acts from the description in the specification for performing the recited function, then the requirements of 35 U.S.C. 112, second paragraph, are satisfied. See *Dossel*, 115 F.3d at 946-47, 42 USPQ2d at 1885 (The function recited in the means-plus-function limitation involved "reconstructing" data. The issue was whether the structure underlying this "reconstructing" function was adequately described in the written description to satisfy 35 U.S.C. 112, second paragraph. The court stated that "[n]either the written description nor the claims uses the magic word 'computer,' nor do they quote computer code that may be used in the invention. Nevertheless, when the written description is combined with claims 8 and 9, the disclosure satisfies the requirements of Section 112, Para. 2." The court concluded that based on the specific facts of the case, one skilled in the art would recognize the structure for performing the "reconstructing" function since "a unit which receives digital data, performs complex mathematical computations and outputs the results to a display must be

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implemented by or on a general or special purpose computer."). See also Intel Corp. v. VIA Technologies, Inc, 319 F.3d 1357, 1366, 65 USPQ2d 1934, 1941 (Fed. Cir. 2003) (The "core logic" structure that was modified to perform a particular program was held to be adequate corresponding structure for a claimed function although the specification did not disclose internal circuitry of the core logic to show exactly how it must be modified.)

(2) If one skilled in the art would not be able to identify the structure, material or acts from description in the specification for performing the recited function, then applicant will be required to amend the specification to include the material incorporated by reference and to clearly link or associate the structure, material or acts to the function recited in the claim. Applicant should not be required to insert the subject matter described in the entire referenced document into the specification. To maintain a concise specification, applicant should only include the relevant portions of the referenced document that correspond to the means (or step)- plus-function limitation. See Atmel, 198 F.3d at 1382, 53 USPQ2d at 1230 ("All one needs to do...is to recite some structure corresponding to the means in the specification...so that one can readily ascertain what the claim means and comply with the particularity requirement of Para. 2.").

IV. DETERMINING WHETHER 35 U.S.C. 112, FIRST *>PARAGRAPH< SUPPORT EXISTS

The claims must still be analyzed to determine whether there exists corresponding adequate support for such claim under 35 U.S.C. 112, first paragraph. In considering whether there is 35 U.S.C. 112, first paragraph support for the claim limitation, the examiner must consider not only the original disclosure contained in the summary and detailed description of the invention portions of the specification, but also the original claims, abstract, and drawings. See In re Mott, 539 F.2d 1291, 1299, 190 USPQ 536, 542-43 (CCPA 1976) (claims); In re Anderson, 471 F.2d 1237, 1240, 176 USPQ 331, 333 (CCPA 1973) (claims); Hill-Rom Co. v. Kinetic Concepts, Inc., **>209 F.3d 1337<, 54 USPQ2d 1437 (Fed. Cir. 2000) (unpublished) (abstract); In re Armbruster, 512 F.2d 676, 678-79, 185 USPQ 152, 153-54 (CCPA 1975) (abstract); Anderson, 471 F.2d at 1240, 176 USPQ at 333 (abstract); Vas-Cath Inc. v. Mahurkar, 935 F.2d at 1564, 19 USPQ2d at 1117 (drawings); In re Wolfensperger, 302 F.2d 950, 955-57, 133 USPQ 537, 541- 43 (CCPA 1962) (drawings).

37 CFR 1.75(d)(1) provides, in part, that "the terms and phrases used in the claims must find clear support or antecedent basis in the description so that the meaning of the terms in the claims may be ascertainable by reference to the description." In the situation in which the written description only implicitly or inherently sets forth the structure, materials, or acts corresponding to a means- (or step-) plus-function, and the examiner concludes that one skilled in the art would recognize what structure, materials, or acts perform the function recited in a means- (or step-) plusfunction, the examiner should either: (A) have the applicant clarify the record by amending the written description such that it expressly recites what structure, materials, or acts perform the function recited in the claim element; or (B) state on the record what structure, materials, or acts perform the function recited in the means- (or step-) plus-function limitation. Even if the disclosure implicitly sets forth the structure, materials, or acts corresponding to a means- (or step-) plus-function claim

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element in compliance with 35 U.S.C. 112, first and second paragraphs, the USPTO may still require the applicant to amend the specification pursuant to 37 CFR 1.75(d) and MPEP § 608.01(o) to explicitly state, with reference to the terms and phrases of the claim element, what structure, materials, or acts perform the function recited in the claim element. See 35 U.S.C. 112, sixth paragraph ("An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof." (emphasis added)); see also *B. Braun Medical*, 124 F.3d at 1424, 43 USPQ2d at 1900 (holding that "pursuant to this provision [35 U.S.C. 112, sixth paragraph], structure disclosed in the specification is 'corresponding' structure only if the specification or prosecution history clearly links or associates that structure to the function recited in the claim. This duty to link or associate structure to function is the quid pro quo for the convenience of employing 112, paragraph 6."); *Medical Instrumentation and Diagnostic Corp. v. Elekta AB*, 344 F.3d 1205, 1218, 68 USPQ2d 1263, 1268 (Fed. Cir. 2003) (Although one of skill in the art would have been able to write a software program for digital to digital conversion, such software did not fall within the scope of "means for converting" images as claimed because nothing in the specification or prosecution history clearly linked or associated such software with the function of converting images into a selected format.); *Wolfensperger*, 302 F.2d at 955, 133 USPQ at 542 (just because the disclosure provides support for a claim element does not mean that the USPTO cannot enforce its requirement that the terms and phrases used in the claims find clear support or antecedent basis in the written description).

V. SINGLE MEANS CLAIMS

Donaldson does not affect the holding of *In re Hyatt*, 708 F.2d 712, 218 USPQ 195 (Fed. Cir. 1983) to the effect that a single means claim does not comply with the enablement requirement of 35 U.S.C. 112, first paragraph. As *Donaldson* applies only to an interpretation of a limitation drafted to correspond to 35 U.S.C. 112, sixth paragraph, which by its terms is limited to "an element in a claim to a combination," it does not affect a limitation in a claim which is not directed to a combination.

MPEP § 2181

END OF DOCUMENT

EXHIBIT 2

Landis on Mechanics of Patent Claim Drafting

FIFTH EDITION

ROBERT C. FABER

INCORPORATING RELEASE NO. 2
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Note that the foregoing claim covers a total of six specific compounds, for any use to which they can be put. This illustrates the very common class of inventions in which new molecules are claimed by structural formula. It also illustrates the use of what is termed "*Markush*," or alternative, terminology to cover several different compounds with a single claim (see section 6:2).

See section 2:9 for comments on dependent composition claims, and section 6:8 on *Jepson*-type claims in this area.

Summary

Composition of matter claims list the chemical ingredients (compounds, elements or radicals) making up the composition or compound. The ingredients or elements may be claimed narrowly (specific named components), with intermediate scope (a group of similar elements functionally equivalent), or broadly as to function performed, where the prior art permits. Where necessary to novelty, etc., the proportions or other conditions or parameters of the compound are stated, usually in ranges of concentration of ingredients. The intended use for the composition (rust inhibition, antibiotic) may or may not be stated in the preamble. (See section 6:7 for details on the effect of preamble limitations.) The problems in chemical practice come primarily with obviousness questions over prior art and how much disclosure is needed in the specification, not primarily in the techniques of drafting claims.

§ 6:2 "Markush" Expressions

Markush expressions are alternative expressions described in MPEP section 2173.05(h):

... a *Markush* group, recites members as being 'selected from the group consisting of A, B, C.' *Ex parte Markush*, 1925 C.D. 126; sanctions claiming a genus expressed as a group consisting of certain specific materials. Inventions in metallurgy, refractories, ceramics, pharmacy, pharmacology and biology are most frequently claimed under the *Markush* formula but purely mechanical features or process steps may also be claimed by using the *Markush* style of claiming, see *Ex parte Head*, 214 U.S.P.Q. 551 (Bd. Appl's 1981); *In re Gaubert*, 187 U.S.P.Q. 664 (C.C.P.A. 1975) and *In re Harnisch*, 206 U.S.P.Q. 300 (C.C.P.A. 1980).

Further, as to the form of language for a *Markush* grouping MPEP section 2173.05(h) states: "It is improper to use the term 'comprising' instead of 'consisting of'." In other words the group must be recited as closed ended.

Rather than using "selected from the group consisting of," one can simply list the group members, with "or" preceding the final member (see below in this section). Although "a" used as an article to introduce a claim element could mean one or more in an open-ended patent claim, "a" used with "consisting of" indicates only one member of a *Markush* group. The claim at issue⁸ included a list of Lewis acid inhibitors in a *Markush* group. It later referred to "a" Lewis inhibitor. This was held not to refer to more than one inhibitor, but to indicate only one of those inhibitors. That is because a *Markush* group is close-ended.

Furthermore, *Markush* grouping can lead to possible double inclusion of a claimed element. An example in the MPEP section 2173.05(h) is a *Markush* group: "selected from the group consisting of . . . halogen . . . chloro . . ." The group is acceptable although "halogen" is generic to "chloro." The claim itself must be evaluated for indefiniteness.

The *Markush* expression is commonly used in chemical cases as it deals with naming a selected group of materials. However, practitioners sometimes use them in nonchemical, for example, mechanical and electrical cases, where the rationale for the use of such an expression will equally apply.^{8.1} The Manual section says it may be used for "purely mechanical features," like simple screws or staples, or even individual large, complex structures. It may be used for "process steps," for example, gluing or stapling.

A *Markush* group is a sort of homemade generic expression covering a group of two or more different materials (elements, radicals, compounds, etc.), mechanical elements, or process steps, any one of which will work in the combination claimed.

There are two requirements to satisfy a *Markush* group: (1) the generic field must be present and (2) one of the specified members of the group must be in the generic field. In *Biovail Laboratories, Inc. v. TorPharm, Inc.*,^{8.2} the claim was "a wetting agent" "from the group consisting of" several chemicals. To meet this claim element, a material must be both the generic "wetting agent" and one of the

8. *Abbott Labs. v. Baxter Pharm. Prods., Inc.*, 334 F.3d 1274, 67 U.S.P.Q.2d [BNA] 1191 [Fed. Cir. 2003].

8.1. *Cf. Superguide Corp. v. DirecTV Enters., Inc.*, 358 F.3d 870, 69 U.S.P.Q.2d [BNA] 1865 [Fed. Cir. 2004].

8.2. *Biovail Labs., Inc. v. TorPharm, Inc.*, 326 F. Supp. 2d 605, ____ U.S.P.Q.2d [BNA] ____ [E.D. Pa. 2004].

group members. The "wetting agent" was not defined merely by being a member of the group. The court separately construed the term "wetting agent" from the prosecution history, dictionaries, and treatises. In addition, it had to be a group member. But a group member that is not also a wetting agent would not satisfy the generic term "wetting agent."

Treatment of a claim element as a *Markush* group occurs even if that treatment was not intended.⁹ For example, prior art teaching one member of the group will be prior art as to the entire *Markush* group. If you do not intend to claim a *Markush* group, do not use alternative language for a series of related alternative elements.

A typical example, from the previous section, Claim 12:

... a halogen selected from the group consisting of chlorine and bromine.

Note that this covers either chlorine or bromine, either of two specific elements out of five in the halogen group, in apparent violation of the "rule" against alternative claiming discussed in section 3:13. The *Markush* doctrine originated out of necessity. In the previous example, there is no generic word for the specified group of two halogens out of five. To refuse a generic claim because of a paucity of language seems unreasonable. Thus, *Markush* language is used to create an artificial generic expression.

Mr. Markush's claim in question involved: "a material selected from the group consisting of aniline and halogen substitutes of aniline."

Markush terminology may be used in claims in any of the statutory classes of utility patents; wherever several alternative types of material are involved. Thus, although the claim may be to a mechanical structure, an article of manufacture, the particular element of that structure that is described by a *Markush* expression may be a chemical type limitation. As an example of an article of manufacture, in the resistor of section 5:1, if the only materials that would work for the terminal stripes were copper, silver and aluminum, or if for any other reason a claim limited to those three materials were desired, clause (c) of Claim 7 could read as follows: "a stripe of a *conductive metal selected from the group consisting of copper, silver and aluminum at each end of the core in electrical contact with the carbon coating.*"

9. See *Brown v. Air Prods. & Chems., Inc.*, 229 F.3d 1120, 56 U.S.P.Q.2d (BNA) 1456 (Fed. Cir. 2001).

For a process claim including a series of materials or elements that may be used as alternatives, consider the example in section 4:7 of treating polyethylene articles, and suppose that the acid could be only concentrated sulfuric, nitric, or phosphoric acid.

The claim would then read:

- 5A. A process for treating the surface of a polyethylene article to increase its receptivity to a printing ink, which comprises:

exposing the surface of the article to a saturated solution of sodium dichromate in *an acid selected from the group consisting of* concentrated sulfuric, nitric and phosphoric acids.

Markush group claiming can be extended to alternative process steps. In a process limitation, the *Markush* group consists of a group of steps: "... weakening the bond by a process selected from the group consisting of heating, freezing, and pulling the pieces apart. . . ." In Claim 5A above, the exposing step may be written as an additional *Markush* grouping, "wherein the exposing is performed by a process . . .," or "wherein the exposing step is selected from the group consisting of dipping, spraying and painting" or even "wherein the exposing is done by dipping, spraying or painting," since the "or" alternative is also permitted, see below.

In the foregoing examples, the italics indicate the *Markush* phraseology. The precise format should, but not must, be followed exactly. The *Markush* expression preferably has the form "a _____ selected from the group consisting of _____ . . . and _____." Note that the word "consisting" limits the claim to the named group, as mentioned in section 2:6.

An interesting example is from Stebbings patent 3,234,948 on a cheese filter cigarette: "2. A cigarette filter according to claim 1, in which the cheese comprises grated particles of cheese selected from the group consisting of Parmesan, Romano, Swiss and cheddar cheeses." This illustrates the use of a *Markush* expression to define one element of an article of manufacture claim.

The claim in which the expression appears may have the transition word "comprising" after the preamble, but the *Markush* expression of the claim may never include "comprising." Instead, the *Markush* expression must begin only with "the group consisting of."

Further, the group members are listed separated by commas. Where the *Markush* expression is introduced by "selected from the group consisting of," the final member of the group is preceded by

the conjunction "and."¹⁰ Proper practice also permits claiming in the alternative using "or," if a *Markush* group would have been proper, but then you omit the formulaic "selected from the group consisting of":

When materials recited in a claim are so related as to constitute a proper *Markush* group, they may be recited in the conventional [Markush] manner, or alternatively. For example, if "wherein R is a material selected from the group consisting of A, B, C and D" is a proper limitation, then "wherein R is A, B, C or D" shall also be considered proper.¹¹

Under this modification, in the example of Claim 7, one could recite a "stripe of copper, silver or aluminum. . . ." This is much simpler and covers the same thing as the regular *Markush* form.

Improper use of the *Markush* form, even if unintentional, may have an unexpected result. In *Superguide Corporation v. DirecTV Enterprises, Inc.*,^{11,1} the patentee claimed ". . . information which meet at least one of the desired program start time, the desired program end time, the desired program service, and the desired program type. . . ." The Federal Circuit said that language required one member of each category be present in order to meet the claim element. Had "or" been used in place of "and," there might have been only need for one element from one category to meet the claim element. Alternatively, had the expression begun "information which meet at least one of the group consisting of the desired program . . .," that would have become a properly recited *Markush* Group and the patentee's construction might have prevailed.

There once was a policy against *Markush* claims of diminishing or varying scope (Claim 1—the group A, B, C, and D; Claim 2—A, B, and C), but this is now considered proper *unless* ". . . such a practice renders the claims indefinite [this would be rare] or if it results in undue multiplicity."¹²

Markush claims also may be allowed as subordinate ("subgenus") claims under a broader ("genus") claim not naming particular materials¹³ (see section 6:9 on generic and species claims). Under this liberalized practice, for example, Claim 1 could cover conductive materials broadly; Claim 2, a *Markush* group of five materials; claim 3, a limited group of three preferred materials; etc.

10. MPEP § 2173.05(h).

11. *Id.*

11.1. *Superguide Corp. v. DirecTV Enters., Inc.*, 358 F.3d 870, 69 U.S.P.Q.2d (BNA) 1865 (Fed. Cir. 2004).

12. MPEP § 2173.05(h), section 8:3.

13. MPEP § 2173.05(h).

When claiming specific compounds per se (that is, molecules), questions have arisen in how closely related the members of the *Markush* group must be for the claim to be proper: could one claim such disparate things as air, earth, fire, or water? Polypropylene, benzene hexafluoride, tantalum sesquinitride, or undiscovered element 117? MPEP section 2173.05(h) requires that the materials in the *Markush* group must ordinarily "belong to a recognized physical or chemical class or an art-recognized class." Air, earth, fire, and water would not suffice.

Unlike *Markush* groupings that recite materials or a compound, *Markush* groups in a claim reciting a process or a combination need not belong to one class.¹⁴ MPEP section 2173.05(h) says "it is sufficient if the members of the group are disclosed in the specification to possess at least one property in common which is mainly responsible for their function in the claimed relationship, and it is clear from their very nature or from the prior art that all of them possess this property." This lends itself to making a broad range of mechanical equivalents, sharing one common property, part of a *Markush* grouping: "a resting surface selected from the group consisting of a chair, a bench and a stool." The *Markush* grouping is more easily explained if the clause including it includes the property that the members of that group possess, for example, "a resting surface." Alternatively, that property may be recited in a preceding claim without the *Markush* group and the specified group may then be recited in a following dependent claim, as "wherein the resting surface is selected. . . ."

In mechanical cases, there would usually be some generic word available, often a "means for" clause, avoiding the need for *Markush* claiming and making its use optional. Yet, the *Markush* claiming is also available. For example, the *Markush* grouping a "fastener selected from the group consisting of nail, rivets and screws" may instead be preceded by the generic claim reciting "a fastener" or a "means for fastening."

MPEP section 803.02 concerns restriction requirements for *Markush* groups and permits such requirements when members of a group present independent and distinct inventions. Then the examiner may require provisional election of a single species. As MPEP section 803.02 states:

Broadly, unity of invention exists where compounds included within a *Markush* group (1) share a common utility and (2) share a substantial structural feature disclosed as being essential to that utility.

14. *In re Harnisch*, 206 U.S.P.Q. (BNA) 300 (C.C.P.A. 1980).

The above appears to relate only to claims for two different compounds. When claiming a process or a combination of materials, standard Patent and Trademark Office practice is more liberal:

it is sufficient if the members of the group are disclosed in the specification to possess at least one property in common which is mainly responsible for their function in the claimed relationship and it is clear from their very nature or from the prior art that all of them possess this property.¹⁵

Also, where a *Markush* expression is applied only to a portion of a chemical compound (for example, Claim 12, a radical such as methyl, ethyl, etc.), the propriety of the grouping is determined by consideration of the compound as a whole, and does not depend on there being a community of properties in the members of the *Markush* expression per se.¹⁶

Summary

Markush claims define alternative chemical ingredients that can be used in a compound, composition, alternative steps in a process, or alternative choices for an article. Where claiming alternative compounds, they must not be "patentably distinct" under present Office practice; otherwise, they need only have a common property useful in the combination claimed. The standard format is "a _____ selected from the group consisting of A, B, and C." There are many detailed rules on Markush practices described in the preceding section, and modern Patent and Trade Office practice may be to restrict use of Markush claims and to require restriction between inventions the examiner thinks are independent and distinct.

§ 6:3 Trademarked Materials; Arbitrary Names

Where an ingredient in a composition to be claimed is known only by a trademark or by an arbitrary name used in trade, according to the Patent and Trademark Office,¹⁷ such a name may be used in the application and claims *only* where the term has a fixed and definite meaning, either well known in the literature or defined in

15. MPEP § 2173.05(h).

16. MPEP § 2173.05(h); see *Ex parte Price*, 150 U.S.P.Q. (BNA) 467 (Bd. App. 1965).

17. MPEP § 608.01(v); MPEP § 2173.05(u).

EXHIBIT 3

McGraw-Hill Dictionary of Scientific and Technical Terms

Fifth Edition

Sybil P. Parker
Editor in Chief

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On the cover: Photomicrograph of crystals of vitamin B₁₂,
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Locustidae

logarithmic profile of velocity

1163

LOCUSTIDAE

Drawing of the grasshopper
(*Melanoplus mexicanus*)

- The common name for various migratory grasshoppers of the family Locustidae. ['lɒkəst]
- Locustidae** [INV ZOO] A family of insects in the order Orthoptera; antennae are usually less than half the body length, hindlegs are adapted for jumping, and the ovipositor is multipartite. ['lɒkəstɪd,de]
- lodar** [NAV] A direction finder used to determine the direction of arrival of loran signals, free of night effect, by observing the separately distinguishable ground and sky-wave loran signals on a cathode-ray oscilloscope and positioning a loop antenna to obtain a null indication of the component selected to be most suitable. Also known as lorad. ['lɒ,dɑr]
- lode** [GEOL] A fissure in consolidated rock filled with mineral, usually applied to metalliferous deposits. ['lɒd]
- lode claim** [MIN ENG] That portion of a vein or lode, and of the adjoining surface, which has been acquired by a compliance with the law, both Federal and state. ['lɒd,kli:m]
- loden cloth** [TEXT] A fleecy fabric woven from coarse wool in the Tyrolean area of Austria and Germany; it is naturally water-repellent. ['lɒd-ən,kloth]
- lodestone** [MINERAL] The naturally occurring magnetic iron oxide, or magnetite, possessing polarity, and attracting iron objects to itself. Also known as Hercules stone; leading stone; loadstone. ['lɒd,stɒn]
- lodicule** [BOT] One of the minute membranous bodies found at the base of the carpel in most flowering grasses; usually occurs in pairs. ['lɒd-ə,kjʊl]
- lodos** [METEOROL] A southerly wind on the Black Sea coast of Bulgaria. ['lɒ-dɒs]
- lodranite** [GEOL] A stony iron meteorite composed of bronzite and olivine within a fine network of nickel-iron. ['lɒ-drənɪt]
- Loeffler's syndrome** [MED] Extensive infiltration of the lung by eosinophils, and eosinophilia of the peripheral circulation. Also known as eosinophilic pneumonitis. ['lefləz,sɪn,drom]
- loellingite** [MINERAL] FeAs_2 . A silver-white to steel-gray mineral composed of iron arsenide with some cobalt, nickel, antimony, and sulfur; isomorphous with arsenopyrite; a source of arsenic. Also known as leucopyrite; lauellingite. ['lel-ɪŋ,ɪt]
- loess** [GEOL] An essentially unconsolidated, unstratified calcareous silt; commonly it is homogeneous, permeable, and buff to gray in color, and contains calcareous concretions and fossils. ['les]
- loess kintchen** [GEOL] An irregular or spheroidal nodule of calcium carbonate that is found in loess. ['les,kɪntʃən]
- loewellite** [MINERAL] $\text{Na}_2\text{Mg}_2(\text{SO}_4)_4 \cdot 5\text{H}_2\text{O}$. A white to pale-yellow mineral composed of hydrous sulfate of sodium and magnesium. ['ləv-ɪt]
- lofar** [NAV] A submarine detection system using autocorrelation techniques for long-range analysis of patterned sound picked up at the low-frequency end of the sound spectrum by underwater hydrophones of the Caesar submarine detection system. Derived from low-frequency acquisition and ranging. ['lɒ,fɑr]
- loft** [BUILD] 1. An upper part of a building. 2. A work area in a factory or warehouse. ['TEXT] 1. The quality of resilience possessed by wool that permits it to return to its original shape after deformation. 2. The degree of bulkiness of manufactured fibers and blends. ['lɒft]
- loft bombing** [ORD] A method of aerial bombing in which the delivery plane approaches the target at a very low altitude, makes a definite pull-up at a given point, releases bomb at predetermined point during the pull-up, and tosses the missile on the target. ['lɒft,bɒm-ɪŋ]
- loft building** [BUILD] A building with a large open floor area. ['lɒft,bɪld-ɪŋ]
- log** [COMMUN] A written record of radio and television station operating data, required by law. [COMPUT SCI] A record of computer operating runs, including tapes used, control settings, halts, and other pertinent data. [ENG] The record of, or the act or process of recording, events or the type and characteristics of the rock penetrated in drilling a borehole as evidenced by the cuttings, core recovered, or information obtained from electronic devices. [MATER] Unshaped timber either rough or squared. [NAV] 1. An instrument for measuring the speed or distance or both traveled by a vessel. 2. A written record of the movements of a craft, with regard to courses, speeds, positions, and other information of interest to navigators, and of important happenings aboard the craft. 3. A written record of specific related information, such as that concerning performance of an instrument. ['lɒg]
- Loganiaceae** [BOT] A family of mostly woody dicotyledonous plants in the order Gentianales; members lack a latex system and have fully united carpels and axile placentation. ['lɒ,gæn-ɪ'æ-si:ə]
- Logan slabbing machine** [MIN ENG] A machine that has three cutting chains; two are horizontal—one at the base of the coal seam, the other at a distance from the floor; the third is mounted vertically and shears off the coal at the back of the cut; a short conveyor transfers the coal to the face conveyor. ['lɒ-gən'slab-ɪŋ mæʃɪn]
- logarithm** [MATH] 1. The real-valued function $\log u$ defined by $\log u = v$ if $e^v = u$, e^v denoting the exponential function. Also known as hyperbolic logarithm; Napierian logarithm; natural logarithm. 2. An analog in complex variables relative to the function e^z . ['lɒg-ə,rɪθ-m]
- logarithmically convex function** [MATH] A function whose logarithm is a convex function. ['lɒg-ə,rɪθ-mɪk-ly'kɒn'veks,fʌŋk-shən]
- logarithmic amplifier** [ELECTR] An amplifier whose output signal is a logarithmic function of the input signal. ['lɒg-ə,rɪθ-mɪk'ampl-ɪf-ər]
- logarithmic coordinate paper** [MATH] Paper ruled with two sets of mutually perpendicular, parallel lines spaced according to the logarithms of consecutive numbers, rather than the numbers themselves. ['lɒg-ə,rɪθ-mɪk kə'ɔrd-ən-ət,pæpər]
- logarithmic coordinates** [MATH] In the plane, logarithmic coordinates are defined by two coordinate axes, each marked with a scale where the distance between two points is the difference of the logarithms of the two numbers. ['lɒg-ə,rɪθ-mɪk kə'ɔrd-ən-əts]
- logarithmic curve** [MATH] A curve whose equation in cartesian coordinates is $y = \log ax$, where a is greater than 1. ['lɒg-ə,rɪθ-mɪk'kərv]
- logarithmic decrement** [PHYS] The natural logarithm of the ratio of the amplitude of one oscillation to that of the next which has the same polarity, when no external forces are applied to maintain the oscillation. ['lɒg-ə,rɪθ-mɪk'dekrə-mənt]
- logarithmic derivative** [MATH] The logarithmic derivative of a function $f(z)$ of a real (complex) variable is the ratio $f'(z)/f(z)$, that is, the derivative of $\log f(z)$. ['lɒg-ə,rɪθ-mɪk də'rɪv-ə-tɪv]
- logarithmic differentiation** [MATH] A technique often helpful in computing the derivatives of a differentiable function $f(x)$; set $g(x) = \log f(x)$ where $f(x) \neq 0$, then $g'(x) = f'(x)/f(x)$, and if there is some other way to find $g'(x)$, then one also finds $f'(x)$. ['lɒg-ə,rɪθ-mɪk,dɪf-ə,renʃ-ə'shən]
- logarithmic diode** [ELECTR] A diode that has an accurate semilogarithmic relationship between current and voltage over wide and forward dynamic ranges. ['lɒg-ə,rɪθ-mɪk'di-ɒd]
- logarithmic distribution** [STAT] A frequency distribution whose value at any integer $n = 1, 2, \dots$ is $\lambda^n / (-n) \log(1 - \lambda)$, where λ is fixed. ['lɒg-ə,rɪθ-mɪk,dɪstr-ə'bjʊt-shən]
- logarithmic equation** [MATH] An equation which involves a logarithmic function of some variable. ['lɒg-ə,rɪθ-mɪk i'kwā-zhən]
- logarithmic fast time constant** [ELECTR] Constant false alarm rate scheme which has a logarithmic intermediate-frequency amplifier followed by a fast time constant circuit. ['lɒg-ə,rɪθ-mɪk'fæst'tɪm,kən'stənt]
- logarithmic growth** See exponential growth. ['lɒg-ə,rɪθ-mɪk'grəʊθ]
- logarithmic multiplier** [ELECTR] A multiplier in which each variable is applied to a logarithmic function generator, and the outputs are added together and applied to an exponential function generator, to obtain an output proportional to the product of two inputs. ['lɒg-ə,rɪθ-mɪk'mʌlt-ɪ-plɪ-ər]
- logarithmic potential** [PHYS] A potential function that is proportional to the logarithm of some coordinate; for example, a straight, electrically charged cylinder of circular cross section and effectively infinite length gives rise to an electrostatic potential that is the sum of a constant and a term proportional to the logarithm of the distance from the cylinder's axis. ['lɒg-ə,rɪθ-mɪk pə'ten-ʃəl]
- logarithmic profile of velocity** [FL MECH] The mean velocity parallel to a boundary of a fluid in turbulent motion as a function of distance from the boundary, on the assumption that the shear-